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STATISTICAL METHODS FOR ASSESSING BUILDING PERFORMANCE

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Technology Branch
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ABSTRACT

In fiscal year (1987-88) Public Works Canada, Headquarters, sponsored a project entitled "Statistical Methods for Assessing Building Performance". The purpose of the project was to recommend standardized sampling procedures to assess occupants' perception of their work setting. Information from an occupant survey would be used by facility managers to improve client satisfaction with the accommodation provided. There is a pervasive attitude among facility managers that "professionals" know the performance of a facility better than the pople who occupy the space. PWC in its role as custodian, needs methods to poll occupants and tap into this valuable source of building performance information.

This report presents three methods to administer and analyse questionnaires: 1) University of California at Irvine (UCI) Program in Social Ecology, 2) Short questionnaire developed through PWC contracts, and 3) Delphi method. Comments from other survey approaches and the co-operative work done by PWC and Virginia Polytechnic Institute (VPI) are also reported. Each method has advantages and drawbacks. These are summarized in a table (see Section 1.1) provided to guide the application of each tool.

Revenue Canada Taxation provided an office facility in which to pilot test two questionnaires (UCI and Short). A summary of the findings from the field work is provided in Section 1.2 and 1.3 respectively. PWC has no direct field work with the Delphi method or the developments from VPI and the discussion provided is drawn from experience over several years.

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1.0 SUMMARY

The ultimate value of any questionnaire depends on its intended use. At the outset of any survey, it must be known what information is desired or required.

The purpose of the questionnaire instruments investigated in this project is to guide facility managers to action which would improve a building's performance from the perspective and pecreption of the occupants. The ultimate success of the questionnaire is to accurately and reliably guide facility manager in what action to take. Other indicators of success are: How well does the questionnaire qualify the information? How well do the results from the analysis answer "is any action necessary " and them "what do I do?" How often does the questionnaire guide facility managers to a right answer?

Questionnaire framing and analysis should be designed to provide a conceptual model for deciding what action to take. The conceptual model of the questionnaire may be structured to ask for pieces to complete a puzzle, or to provide answers for what should be done. The future usefulness of the data collected with a questionnaire is set at the conceptual stage. That is, the structure determines whether the database will be a "dead" set of facts or a responsive statistic which can be queried for further analysis.

Analyzing the differences between instruments (such as how questions are asked, what is asked, etc.) may seem pernickety or to be delving into the subtle. However these represent fundamental differences in what the instrument will provide. This is an important and potentially deceptive aspect of comparing different surveys because wrong methods sometimes produce correct answers.

On October 14 & 15/87, Revenue Canada employees participated in a pilot facilities assessment project by completing questionnaires on the office environment. Two different surveys were distributed as listed below. The University of California at Irvine (UCI) survey was a set of five questionnaires designed to address each employee's reaction to the work environment. The Short survey was a 2-page questionnaire with standardized questions that are always used, regardless of the specific conditions of the building under study. Sections 1.2 and 1.3 present the summary of findings from these surveys.

Questionnaire	# Distributed	# Returned	%
UCI	265	200	75%
Short	50	45	90%
TOTAL	**315**	**245**	**78%**

1.1 Comparison of different methods

The table on the following pages is a summary and cross-comparison of the three principle methods investigated. The methods are discussed in detail in Section 2 "Questionnaire Instruments".

CRITERIA	UCI	SHORT	DELPHI
Underlying principles.	Identify links between facility design, employee productivity, and organizational effectiveness.	Comparison of occupants ratings of office building performance to a norm derived from previous building surveys.	Develop theme proposition(s) in a group of decision makers.
Respondent completion time.	20 - 60 minutes. Varies with the questions selected.	up to 10 minutes.	up to 120 minutes
Time required to analyze survey.	20 days	2 days	10 days
Application: Bottomline Use.	For sensitive, longitudinal observations to establish causal links between individuals, productivity, organizations, and facilities.	For a quick but not necessarily accurate indication of building performance.	Forecasting and gaining concensus on politically sensitive topics.

CRITERIA	UCI	SHORT	DELPHI
Validation of responses.	This is a relatively new survey. Reliability and validity of data are being compiled through longitudinal surveys of 500 employees at 10 organizations. Additional validation may be done by instrument readings to assess the degree of convergence between self reports and environmental monitoring data.	Responses are related to a database of previous surveys from large, new buildings (<10 years in service). This make comparison to older buildings (>20 years in service) somewhat questionable.	Validation of dat is achieved by statistical facto analysis using 10 factors. Examples are: equivocation relevance, and malleability of responses.

CRITERIA	UCI	SHORT	DELPHI
Strengths or benefits of questionnaire	Uses targeted questions or issues. Data is fit to a statistical model. Questionnaire relies heavily on established environmental psychology models. Uses direct measures and straight forward, conventional statistics. Offers excellent opportunity for collaboration between facility managers and behavioral researchers. The longitudinal research design is establishing a foundation upon which causal links between facility problems, employee complaints, job performance, and well-being can be made.	The questions are standardized so the questionnaires can be distributed "immediately" without interviews with key people to tailor the questions. The analysis is easy and uses basic statisstics.	Forecasting and prediction of trends or outcome from "in-the-know people. Especially useful for reaching concensus on politically sensitive topics (e.g., day care a work). Allows anonymous stating of opinion and ability to change one's opinion without "loss of face".

CRITERIA	UCI	SHORT	DELPHI
Weakness or limitations of questionnaire	The analysis of the inter-relationships among the data fromthe various questionnaires requires the use of multivariate statistics (e.g., BMD-P, SPSS Regression, and Manova) for approporiate interpretation. Extensive data coding, entry, and analysis are requires making the analysis long and somewhat cumbersome.	Results are general. The Inadequate breadth and depth of information collected leaves the analysis with little statistical power. The over dependence on the significance of the average value loses valuable information from outliers. Synergistic effect of multiple stressors is lost in averages. Compromises the long term benefits of having a rich database to query for the short term convenience of survey and analysis. The instrument may be asking the wrong questions for answering the needs of facility mangers. The results are not related to other research in this area.	Uses indirect indicators so the analysis is complex (and presently proprietary). Needs a highly trained statis-tician to interpret results and then a building scientis to relate the results to building specific action.

1.2 Summary of Findings from the Field Trial of the UCI Questionnaire

This summary represents the survey findings from the entire sample (rather than specific Branches or floor areas) at the Revenue Canada Taxation District Office in Hamilton (RCTH)[1]. The discussion is grouped into three sections: Findings Related to Management; Findings Related to Computers; and Findings Related to the Building. Although exact ratings and time-loss estimates varied between groups, all groups reported the same overall areas of greatest concern. The analysis involved looking for patterns in how individuals rated the physical aspects of their work surroundings, specifically, the environmental features.

Findings Related to Management The findings related to management are derived mainly from the Checklist of Work-Related Experiences. This was a two-page questionnaire listing 35 physical, emotional, organizational and environmental experiences of the workplace. For each item, participants were asked to estimate the relative frequency of the work experience on a 5-point scale ranging from "always" to "never". Results were a useful indicator of the frequency of day-to-day events in the workplace. Both positive and negative experiences were reported.

Results are summarized in Table 1, and are grouped into two categories: positive and negative. A high mean score for a positive experience is desirable, whereas a high mean frequency for a negative experience may signify a problem in the workplace.
All groups reported relationships with co-workers as fairly good, with frequent supportive interactions (mean 3.7) and few conflicts or difficulties contacting co-workers (mean 2.0). However, the overall level of employee morale was rated well below these relations with co-workers (mean 2.4). This difference may indicate that individuals distinguish between relations with immediate co-workers and overall unit or Branch morale. Thus, there may be room to improve the overall office morale, and it may be most appropriate to approach it by getting Branches to work more closely and be more supportive, rather than focussing on individual relations within work units.

Unlike a private sector industry which produces a product with which the employees can identify, the product of Revenue Canada is service to the public. As such, it may be

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[1] data input and statistical analysis were provided by the University of California at Irvine, Focused Research Program on Work Environments, November 1987.

more difficult to instill a sense of loyalty or association with a service. It is suggested that a focal point for RCTH employees be provided which would contribute to a sense of group identity. Communication aids such as a RCTH newsletter, in addition to the bulletin board on the 7th floor in front of the elevator, would help to improve a sense of identity with RCT.

Participants report good spirits (mean 3.6) much more frequently than feeling excited or creative in their work (mean 2.6). The Managers at this District Office feel that there is tolerance within job descriptions for employees to personalize the way they perform the duties. However, much of the work requires adherence to rules. The work is mentally intense and often stressful. Employees are regularly in an adversarial roll, representing Revenue Canada (the tax collector) to the general public (the tax payer). As it is not feasible to provide designated rest spots for employees, it is suggested that a more aesthetically pleasing work setting be provided to improve the general work setting. Greater use of plants and coordination of colour and furnishing would assist.

Of all the negative work-related experiences, the most frequently reported response was feeling fatigued and overworked (mean 3.5). Physiological and psychological fatigue may contribute to this perception. It is likely that the intense and adversarial nature of the work is the primary contributor to these feelings. The contribution of the physical setting cannot be determined by this survey alone.

Findings Related to Computers The Employee Attitudes questionnaire was a three-page survey designed to assess employees' general attitudes about the building, organization, and fellow employees. In addition, attitudes about current computer use and support, and feelings about the upcoming automation were included. All questions (except those assessing computer adjustability) were scaled from 1 to 5. The anchors differed from question to question (e.g., "not at all" to "a great deal", or "not at all satisfied" to "very satisfied") but remained consistent in direction (i.e., the higher the number the more positive the attitude).

This questionnaire was used as an indication of general satisfaction, and for comparison to the specific ratings in other questions.

In general, RCTH employees are positive about the pending automation of office functions. Most feel that their job will be easier once RCTH is automated (mean 3.3) and are

confident with their ability to learn to work with computers (mean 4.2). At the same time, a majority stated that they did not want RCTH to automate (mean 3.1). This feeling may reflect concern for job security, and a (perceived or real) fear that the technological change may mean fewer jobs in the future.

Presently the majority of employees who use computers at work (n=131) are satisfied with the current computer support. That is, they are satisfied with the training received on the computer equipment now used (mean 3.3) and the user support for the computer equipment now used (mean 3.2).

Employees reported that the computer workstation they use most often can be adjusted. That is, the screen can be tilted, it swivels, and it has adjustments for brightness and contrast. This response indicates that people know how to work these controls to suit individual preferences. Less than one-third of computer users reported that the keyboard height was adjustable. Verification & Collections has the majority of computer users (54%) and employees in the Branch reported the highest frequency of soreness in neck or shoulders while at work (mean 3.1) and soreness in lower back while at work (mean 2.8). This indicates that a review of the furniture set-up for work with computers is required.

Table 2 summarizes the findings related to computers.

Findings Related to the Building The Ratings of Environmental Features was a 7-page questionnaire listing 46 features of the existing facilities. For each item, participants are asked to evaluate the environmental feature on a 7-point scale ranging from "excellent" to "very poor," and "not applicable." The participants are then asked to identify key hassles frequently associated with that aspect of the environment and to estimate the average minutes-per-day, or per-week, of productive work time lost as a result of dealing with those hassles.

As this questionnaire covered a wide range of physical conditions within the workplace, the results were a useful index of employees' impressions about the environmental quality of their office. The survey also revealed which aspects of the environment employees rated most favorably or unfavorably, and which environmental problems were identified by employees as being associated with the greatest loss of productive work time during a typical work day.

Two approaches to interpret respondents ratings of environmental features were used. The first was to consider

the severity of complaints about a particular feature, and the second approach examined the prevalence of complaints. The relative severity of environmental problems were assessed by two related measures from the Ratings of Environmental Features questionnaires: 1) the average rating of quality associated with different features listed on the survey, and 2) the magnitude of time-loss associated with each of the features. Prevalence was measured by the percentage of respondents within a Branch indicating that they lost productive work time each day due to a specific feature of the environment. The ratings of environmental features was used as a diagnostic tool to make relative and comparative evaluations. Neither the ratings nor the time-loss estimates were used as absolute measures.

Table 3 presents the severity of complaints about environmental features. Table 4 presents the prevalence of complaints about a particular problem by estimating the average time-loss due to that environmental feature. Table 5 combines the severity and prevalence of environmental problems by grouping environmental features according to whether they were (1) rated as relatively poor, fair or good, and (2) mentioned as a source of time-loss by specific percentages of the survey participants.

The results presented in Tables 3, 4, and 5 provide insight about the order in which repair jobs or maintenance tasks should be done. It is recommended that these decisions be made in consultation with individuals from the Branch affected by the environmental problem. The approaches are:

1) attend to major problems that affect a lot of people (that is, ratings in the POOR range with more than 8 minutes lost per day, reported by more than 25% of respondents);
2) attend to major problems that affect some employees (that is, the ratings in the POOR range with little time-loss reported (between 3-8 minutes), reported by less than 25% of respondents);
3) attend to environmental features that are not problems in themselves but because of location, arrangement, or availability, cause major time-loss for some staff members; and,
4) attend to environmental features that are neither serious problems nor responsible for major time-loss, but detract from the quality of the work environment.

The findings summarized in Table 5 suggest that the most prevalent and severe environmental problems noted by the respondents concern air quality (air conditioning, ventilation, and circulation), noise distractions (conversational privacy), and the efficiency of the elevator system.

TABLE 1. FINDINGS RELATED TO MANAGEMENT - Checklist of Work-Related Experiences

Frequency of Each Work-Related Experience:
5 - Always 4 - Often 3 - Sometimes 2 - Rarely 1 - Never

Positive Work-Related Experiences:	Mean Frequency
Supportive interactions with co-workers	3.7
Being in good spirits at work	3.6
Feeling in control of pace of work	3.4
Open exchange of ideas with my super	3.3
Feeling energetic at work	3.2
Participate in decisions about project	3.0
Feeling excited about my work	2.8
Can be creative in the work I do	2.6
High employee morale	2.4
Participate in decisions that affect the quality of my work environment	2.2
Negative Work-Related Experiences:	
Fatigued at end of day	3.5
Feeling overworked	3.0
Distractions from too many phone calls	2.9
Soreness in neck or shoulders while at work	2.9
Desire for more plants/natural elements	2.9
Feeling cramped or crowded	2.8
Eyestrain or blurred vision while at work	2.8
Feeling frustrated by "telephone tag"	2.7
Soreness in lower back while at work	2.7
Wasting time by repeating tasks unnecessarily	2.7
Headaches while at work	2.6
Feeling inadequately trained for the work I do	2.5
Insufficient guidance from supervisor	2.5
Unrealistic deadlines for paper work	2.5
Not knowing how to find key information	2.5
Feeling too enclosed in my workstation	2.4
Feeling confused about my responsibilities on a project	2.3
Bothered by glare on computer screen	2.3
Difficulties sleeping at night due to work worries	2.2
Difficulties in contacting supervisor	2.2
Feeling confused about project budgets	2.1
Feeling confused about project schedules	2.1
Soreness in arms, wrists, or hands while at work	2.1
Conflict with co-workers about project priorities	2.0
Difficulties in contacting co-workers	2.0

TABLE 1. FINDINGS RELATED TO MANAGEMENT - Checklist of Work-Related Experiences (continued)

SATISFACTION WITH ORGANIZATION, CO-WORKERS
(1 - not at all satisfied 5 - very satisfied)

Item	Mean
1. Your job at Revenue Canada Taxation	3.3
2. Your co-worker's	3.8
3. Revenue Canada Taxation	3.0

SENSE OF COMMUNITY
(1 - not at all 3 - some 5 - a great deal)

Item	Mean
1. To what extent do you feel a sense of community where you work?	2.5

SATISFACTION WITH AREA OF BUILDING
(1 - not at all satisfied 5 - very satisfied)

Item	Mean
1. Own work area or personal office.	2.6
2. Your branch's area of the Hamilton Federal Building.	2.6
3. The Hamilton Federal Building in general.	2.2

FREEDOM TO DECORATE
(1 - almost no freedom 5 - great deal of freedom)

Item	Mean
1. How much freedom do you feel you have to decorate your work environment?	2.1

TABLE 2. FINDINGS RELATED TO COMPUTERS

AUTOMATION (1 - strongly disagree 5 - strongly agree)

Item	Mean
1. I do not want RCT to automate.	3.1
2. I feel my job will be easier once RCT is automated.	3.3
3. I am confident with my ability to learn to work with computers.	4.2

SATISFACTION WITH CURRENT COMPUTER SUPPORT
(1 - not at all satisfied 5 - very satisfied)

Item	Mean
1. Satisfaction with the training received on the computer equipment now used.	3.3
2. Satisfaction with the user support for the computer equipment now used.	3.2

Item	
1. **USE**	
Number who use computers at work.	131
Number who don't use computers at work.	64
2. **ACCESS**	
Number with sole access to a computer.	4
Number sharing computer.	128
3. **MEAN FREQUENCY OF USE** (1 = never 5 = very often)	
At work.	3.2
At home.	1.4
4. **EXPERIENCE**	
Mean years experience with a computer.	5.6
5. **NUMBER OF ADJUSTABLE FEATURES**	
Keyboard height is adjustable.	43
Screen can be tilted.	115
Screen swivels.	124
Brightness and contrast.	126

TABLE 3. FINDINGS RELATED TO THE BUILDING - Ratings of Environmental Features

Ratings of Environmental Features
6 - Excellent 5 - Very Good 4 - Good
3 - Fair 2 - Poor 1 - Very Poor

	Mean Ratings
Mean Score for ALL ratings:	2.9
Features rated in the VERY GOOD and EXCELLENT ranges (4.250-6.0):	
(No mean ratings of features in this range.)	
Features rated in the GOOD range (3.750-4.249):	
Insect and rodent control	4.0
Ease of movement in hallways and walkways	3.9
Access to photocopiers	3.9
Access to microfiche or microfilm readers	3.8
Capabilities of your phone system	3.8
Features rated in the FAIR - GOOD range (3.250-3.749):	
Availability of electrical outlets	3.6
Brightness of the lighting for the work you do	3.6
Quality of lighting for the work you do	3.5
Convenient access to reference materials	3.5
File storage space to suit your work requirements	3.5
Desk top and work surface space to accommodate the work you do	3.5
Convenient access to rest rooms	3.4
Access to enclosed conference areas	3.4
Availability of interview rooms	3.4
Distances between major departments in your building	3.4
Work surface space to accommodate office machines and reference materials	3.4
Overall access to office equipment	3.3

TABLE 3. FINDINGS RELATED TO THE BUILDING - Ratings of Environmental Features (continued)

Features rated in the FAIR range (2.750-3.249):	Mean Ratings
Access to typewriters	3.2
Cleanliness of rest rooms	3.2
Comfort of your chair	3.2
Distances between co-workers' offices	3.2
Availability of a separate waiting area for visitors	3.2
Access to word processors	3.0
Quality of building maintenance	3.0
Availability of plants and other natural features in your work area	3.0
Overall control of lighting for video display units	3.0
Availability of shared work space for team projects	2.8
Features rated in the POOR - FAIR range (2.250-2.749):	
Efficiency of layout in your building	2.7
Availability of book shelves in your work area	2.6
Availability of marker boards and other display surfaces	2.5
Efficiency of the elevator system in your building	2.5
Overall noise control	2.5
Quality of air conditioning	2.4
Ability to adjust your office furniture as your job changes	2.4
Quality of heating	2.3
Aesthetic quality of interview rooms	2.3
Features rated in the POOR range (1.750-2.249):	
Overall air quality in your work area	2.2
Sufficient enclosure of your work-station (e.g., walls, screens) for the job that you do	2.2
Aesthetic quality of your office	2.2
Ventilation and air circulation in your work area	2.1
Lockable storage area for personal items	2.1
Adjustability of your lighting as your job changes	2.0
Visual privacy within your office	2.0
Conversational privacy within your office	2.0
A place to work that is free of distractions	2.0
A place to go where you can relax	1.9
Features rated in the VERY POOR range (1.0-1.749):	
(No mean ratings of features in this range.)	

TABLE 4. FINDINGS RELATED TO THE BUILDING - Productive Work Time-Loss Estimates

	MEAN TIME-LOSS ESTIMATES (MIN./DAY)
Time-loss estimated by 50% or more of respondents:	
Sum of estimated time-loss per day: all features	60.1
Time-loss estimated by 25% to 29% of respondents:	
Overall air quality in your work area	11.3
Efficiency of the elevator system in your building	7.8
Time-loss estimated by 20% to 24% of respondents:	
Quality of air conditioning	11.9
A place to work that is free of distractions	11.6
Ventilation and air circulation in your work area	10.5
Convenient access to reference materials	8.5
Time-loss estimated by 15% to 19% of respondents:	
Overall noise control	12.9
Quality of heating	11.0
Access to photocopiers	6.1
Time-loss estimated by 10% to 14% of respondents:	
Conversational privacy within your office	11.5
Sufficient enclosure of your work-station (e.g., walls, screens) for the job that you do	10.6
Quality of lighting for the work you do	10.0
Comfort of your chair	8.7
Efficiency of layout in your building	7.7
Convenient access to rest rooms	7.5
Overall access to office equipment	6.4
Distances between major departments in your building	6.0

TABLE 4. **FINDINGS RELATED TO THE BUILDING - Productive Work Time-Loss Estimates** (continued)

Time-loss estimated by 5% to 9% of respondents:	MEAN TIME-LOSS ESTIMATES (MIN./DAY)
Capabilities of your phone system	11.6
Visual privacy within your office	10.4
Distances between co-workers' offices	10.0
Brightness of the lighting for the work you do	9.1
File storage space to suit your work requirements	8.6
A place to go where you can relax	6.7
Desk top and work surface space to accommodate the work you do	6.1
Access to word processors	5.8
Availability of book shelves in your work area	5.1
Access to microfiche or microfilm readers	4.6
Work surface space to accommodate office machines and reference materials	4.5
Time-loss estimated by less than 5% of respondents:	
Availability of marker boards and other display surfaces	16.0
Cleanliness of rest rooms	10.0
Quality of building maintenance	7.3
Aesthetic quality of your office	7.0
Lockable storage area for personal items	5.7
Adjustability of your lighting as your job changes	5.0
Ease of movement in hallways and walkways	4.4
Availability of electrical outlets	3.8
Access to typewriters	3.7
Access to enclosed conference areas	2.8
Availability of interview rooms	1.7
Ability to adjust your office furniture as your job changes	1.5
Availability of a separate waiting area for visitors	1.5
Aesthetic quality of interview rooms	1.0

TABLE 5. COMBINATION TABLE - Ratings of Environmental Features and Time-Loss Estimates

Features in the range - **RELATIVELY POOR (1.50-2.49)**:	MEAN TIME-LOSS ESTIMATES (MIN./DAY)
Time-loss estimated by 20% to 29% of respondents:	
Quality of air conditioning	11.9
A place to work that is free of distractions	11.6
Overall air quality in your work area	11.3
Ventilation and air circulation in your work area	10.5
Efficiency of the elevator system in your building	7.8
Time-loss estimated by 10% to 19% of respondents:	
Overall noise control	12.9
Conversational privacy within your office	11.5
Quality of heating	11.0
Sufficient enclosure of your work-station (e.g., walls, screens) for the job that you do	10.6
Time-loss estimated by less than 10% of respondents:	
Availability of marker boards and other display surfaces	16.0
Visual privacy within your office	10.4
Aesthetic quality of your office	7.0
A place to go where you can relax	6.7
Lockable storage area for personal items	5.7
Adjustability of your lighting as your job changes	5.0
Ability to adjust your office furniture as your job changes	1.5
Aesthetic quality of interview rooms	1.0
Features in the range - FAIR (2.50-3.49):	
Time-loss estimated by 10% to 19% of respondents:	
Comfort of your chair	8.7
Efficiency of layout in your building	7.7
Convenient access to rest rooms	7.5
Overall access to office equipment	6.4
Distances between major departments in your building	6.0

TABLE 5. **COMBINATION TABLE - Ratings of Environmental Features and Time-Loss Estimates** (continued)

Features in the range - **FAIR** (2.50-3.49):	MEAN TIME-LOSS ESTIMATES (MIN./DAY)
Time-loss estimated by less than 10% of respondents:	
Distances between co-workers' offices	10.0
Cleanliness of rest rooms	10.0
Quality of building maintenance	7.3
Desk top and work surface space to accommodate the work you do	6.1
Access to word processors	5.8
Availability of book shelves in your work area	5.1
Work surface space to accommodate office machines and reference materials	4.5
Access to typewriters	3.7
Access to enclosed conference areas	2.8
Availability of interview rooms	1.7
Availability of a separate waiting area for visitors	1.5
Availability of plants and other natural features in your work area	----
Overall control of lighting for video display units	----
Availability of shared work space for team projects	----
Features in the range - RELATIVELY GOOD (3.50-4.49):	
Time-loss estimated by 20% to 29% of respondents:	
Convenient access to reference materials	8.5
Time-loss estimated by 10% to 19% of respondents:	
Quality of lighting for the work you do	10.0
Access to photocopiers	6.1
Time-loss estimated by less than 10% of respondents:	
Capabilities of your phone system	11.6
Brightness of the lighting for the work you do	9.1
File storage space to suit your work requirements	8.6
Access to microfiche or microfilm readers	4.6
Ease of movement in hallways and walkways	4.4
Availability of electrical outlets	3.8
Insect and rodent control	---

1.3 Summary of Findings from the Field Trial of the Short Questionnaire

This summary is based on the responses from 45 employees, selected randomly from the total population of 315. The analysis of the ratings is termed the "building-in-use profile" and was prepared by Dick Dillon, Carleton University (November 19/87). The following was prepared by the author based on discussions with Dr. Dillon, from his notes, and from further interpretation of the statistics.

The "building-in-use profile" for the Hamilton D.O. relative to the norms established by the database of this questionnaire is shown in Figure 1. The means plotted in Figure 1, and the standard deviations for each dimension are shown in the first line for each factor listed in Table 6.

Although not priority of facility improvements can be determined from this survey, the following conclusions are drawn from the building-in-use profile (Figure 1).

1) This building's environmental performance is rated lower than the norms in six of the seven dimensions. The only dimension at or above the norms is satisfaction with lighting. For several reasons, it is inappropriate to place much importance on the lighting factor being above the norms. The most reasonable interpretation is that light is at least at the norm.
2) It is not appropriate to conclude that one dimensions is the worst or is worse than the others based solely on the means farthest below the norms. The greatest discrepancy between expected norm and the average rating by the occupants, is in Building Noise Factor. One of the smallest discrepancies is in the Air Factor. However, the mean for Building Noise Factor is at the high end of the scale (expected mean 4.5) and thus has considerable room to move down. On the other hand, air quality is near the bottom of the scale (expected mean 2.3) and has little room to move down. The most reasonable conclusion is that six dimensions are lower than the norms and these six cannot be ranked on the basis of the questionnaire data, in terms of how much they are below the norms. All six are not well liked by the respondents.

Floor Differences Table 6 shows the means and standard deviations for the seven dimensions, listed by floor level. This analysis was done because the information on floors was available and does not imply that differences by floor are meaningful or important. These data can be interpreted in conjunction with what is know about noise, air quality, furniture layout, etc. on the different floors. The basement has only a few responses (n=3) so the results are subject to sampling fluctuations.

Figure 1: Building-in-Use Profile
Revenue Canada Taxation, Hamilton District Office
Sample size = 45

Correlations among dimensions, satisfaction with the work area, ability to do their job because of work area, and floor. Correlations[2] are shown in Table 7. These correlations show the (linear) relationship among all dimensions (i.e., floor and the two criterion measured). For example, the correlations between floor and ability to do work at the work station in +.048 (essentially zero). A few fairly strong correlations are discussed below. Others may be interpreted but, for these data, correlations should be above $^{+}_{-}.40$.

Not surprisingly, rated satisfactions with the work station and ability to do work at the workstation are highly correlated (r=+.80). Ability to do work at the workstation is correlated with the spatial layout factor (r=.42) and privacy (r=.50, r^2=.257). Thus, in a purely descriptive sense, the attitude toward furniture layout and privacy can account to some extent for peoples' ability to do work. A value of .25 for r^2 indicates that 25 percent of the variance in peoples ratings of ability to do their work at the workstation is associated with (in a purely descriptive sense) privacy. Similarly, how satisfied people are with the workstation is related to spatial factor r=.63, r^2=.40). Privacy (r=.48), air quality (r=.46) and temperature (r=.42). Forty percent of the variance in rated satisfaction can be accounted for by knowing the ratings on spatial factor. Temperature and air quality are fairly highly correlated (r=.64), and a similar correlation exists between noise and lighting (r=.63).

Predicting ability to do work and satisfaction from the dimensions Two separate multiple regressions were performed. Table 8 summarizes the relevant data for predicting workstation satisfaction from the seven dimensions and Table 9 summarizes data on predicting ability to work from the seven dimensions.

In multiple regression the best weighted linear combination of the 7 dimensions is determined and the correlations between this linear combination and the variable being predicted is calculated (workstation satisfaction in Table 8 and workability in Table 9). Both multiple regressions are significant (r^2=.57, therefor r=.75 for satisfaction and r^2=.45, therefore r=.57 for workability).

The multiple regressions indicate that more of the variance in satisfaction (and workability) can be accounted for in terms of the seven dimensions than can be accounted for by

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[2] Pearson product moment correlations were used. They are the standard, single, linear correlation.

any single factor. An increase from 40 to 57 percent in r^2 for satisfaction is considerable. The variables that are most useful for predicting satisfaction from the linear combination are the spatial factor (t=3.50), building noise (t=-1.64), lighting (t=1.51), and privacy (t=1.24).

The correlation coefficients indicates that other factors are also correlated with rated satisfaction. Ability to work at the workstation can be predicted better from a linear combination of factors (r^2=.45) than from the best individual factor (r^2=.25 for privacy). The important predictions are spatial (t=2.48), lighting (t=2.26), privacy (t=1.65), and building noise (t=-1.44).

TABLE 6. MEANS AND STANDARD DEVIATION - For the 7 Dimensions, Presented by Floor

B = basement
1 = ground level
2 = second floor
3 = third floor

DIMENSION	FLOOR	SAMPLE SIZE	MEAN	STANDARD DEVIATION
Building Noise Factor	ALL	46	3.88	0.88
	0	3	3.89	1.01
	1	10	3.87	0.97
	2	14	3.73	1.12
	3	19	4.00	0.65
Spatial Factor	ALL	47	3.04	1.17
	0	3	1.75	0.66
	1	10	2.70	0.96
	2	15	3.17	1.38
	3	19	3.33	1.03
Lighting Factor	ALL	45	3.64	1.00
	0	3	3.78	0.38
	1	10	3.26	1.33
	2	14	3.69	1.08
	3	18	3.81	0.79
Office Noise Factor	All	44	2.43	1.08
	0	3	3.33	1.45
	1	10	2.50	1.28
	2	14	2.83	0.89
	3	17	1.90	0.85

TABLE 6. MEANS AND STANDARD DEVIATION - For the 7 Dimensions, Presented by Floor (continued)

DIMENSION	FLOOR	SAMPLE SIZE	MEAN	STANDARD DEVIATION
Temperature Factor	ALL	46	2.24	1.00
	0	3	1.78	1.07
	1	9	1.37	0.43
	2	15	2.02	0.96
	3	19	2.89	0.82
Air Factor	ALL	47	1.97	1.11
	0	3	1.00	0.00
	1	10	1.47	0.69
	2	15	1.80	0.84
	3	19	2.52	1.30
Privacy Factor	ALL	47	1.91	1.12
	0	3	2.22	0.84
	1	10	1.73	1.25
	2	15	1.96	1.01
	3	19	1.93	1.17
Overall Satisfaction with Workspace	ALL	46	2.35	1.23
	0	3	1.00	0.00
	1	10	2.40	1.65
	2	14	2.29	0.99
	3	19	2.58	1.67
How Space Affects Ability to do Work	ALL	46	2.57	1.13
	0	3	2.00	1.00
	1	10	2.60	1.65
	2	14	2.71	0.83
	3	19	2.52	1.07

TABLE 7. CORRELATIONS

Key: FLOOR = floor differences
WORKA = ability to do work
SATIS = satisfaction with workstation
BLDGN = building noise factor
SPATF = spatial factor
LITEF = lighting factor
OFFIN = office noise factor
TEMPF = temperature factor
AIRFA = air factor
PRIVF = privacy factor

	FLOOR	WORKA	SATIS	BLDGN	SPATF	LITEF	OFFIN	TEMPF	AIRFA
FLOOR	1.000								
WORKA	0.048	1.000							
SATIS	0.226	0.798	1.000						
BLDGN	0.062	0.246	0.290	1.000					
SPATF	0.327	0.473	0.632	0.476	1.000				
LITEF	0.152	0.337	0.334	0.627	0.295	1.000			
OFFIN	-.341	0.195	0.107	0.227	-.012	0.046	1.000		
TEMPF	0.545	0.279	0.425	0.336	0.383	0.336	0.005	1.000	
AIRFA	0.446	0.272	0.460	0.353	0.421	0.374	0.130	0.640	1.000
PRIVF	0.005	0.499	0.480	0.161	0.369	0.065	0.417	0.297	0.281

TABLE 8. PREDICTING WORKSTATION SATISFACTION

Dependent variable is: satis
R^2 = 57.1% R^2(adjusted) = 48.2%
s = 0.9195 with 42 - 8 = 34 degrees of freedom

Source	Sum of Squares	df	Mean Square	F-ratio
Regression	38.2304	7	5.461	6.46
Residual	28.7458	34	0.845463	

Variable	Coefficient	s.e. of Coeff	t-ratio
Constant	-0.485729	0.7118	-0.682
temp fact	0.171416	0.2004	0.855
air fact	0.136169	0.1774	0.768
off noise fact	0.182660	0.1725	1.06
spat fact	0.604855	0.1726	3.50
priv fact	0.199744	0.1614	1.24
lite fact	0.286530	0.1894	1.51
bldg noise fa...	-0.390000	0.2375	-1.64

TABLE 9. PREDICTING ABILITY TO DO WORK

Dependent variable is: work abil
R^2 = 45.2% R^2(adjusted) = 33.9%
s = 0.9522 with 42 - 8 = 34 degrees of freedom

Source	Sum of Squares	df	Mean Square	F-ratio
Regression	25.4555	7	3.636	4.01
Residual	30.8302	34	0.906771	

Variable	Coefficient	s.e. of Coeff	t-ratio
Constant	-0.028428	0.7372	-0.039
bldg noise fa...	-0.353586	0.2460	-1.44
lite fact	0.443372	0.1962	2.26
priv fact	0.275297	0.1671	1.65
spat fact	0.444062	0.1788	2.48
off noise fact	0.215650	0.1786	1.21
air fact	-0.058900	0.1837	-0.321
temp fact	0.053546	0.2076	0.258

2.0 QUESTIONNAIRE INSTRUMENTS

This section describes the theory and concepts of the three main approaches investigated. Each discussion covers the principle features of the method, situations where used, advantages, limitations, procedure, and validation of method. Where possible, examples from field work are used to show how the instrument performs. The value and uses of the information collected by each instrument is provided throughout the discussion. A discussion of the VPI method is in Section 2.4. It is less detailed detail because it is not a method aimed at assessing occupant's perception of their work setting.

2.1 University of California, Irvine (UCI) Instruments

The UCI instruments were developed at the Western Research Inventory (WFRI) by Dr. Daniel Stokols for use in facilities programming and evaluation studies. The Inventory has been used by organizations as a diagnostic tool to identify environmental and behavioral problems within existing facilities, to generate programming requirements for the design of future facilities prior to relocation, and to provide post-occupancy evaluations of new facilities. The WFRI instruments were moved into UCI by Dr. Stokols for wider exposure and more extensive scientific validation.

Principle Features of the UCI Method The UCI survey package involves several different questionnaires designed to address each employee's reaction to the work environment. Some questions focus on the physical features in the office, and others are directed at each employee's experiences throughout the work day. PWC worked with the following five questionnaires:

1) Ratings of Environmental Features
This questionnaire asks employees to rate a wide variety of office features and then to estimate time-loss associated with problematic features. Results from these ratings are used to identify environmental conditions that have the most frequent and severe impacts on productive work-time. For example, a very small time-loss experienced by a large number of employees may target an office feature for redesign.

2) Location of Work Activities
This questionnaire helps to identify where employees work throughout the day. It also identifies use of selected office equipment. Information from this instrument provides documentation of heavily used areas, workstations, and other resources within the work setting.

3) Checklist of Work-Related Experiences
This questionnaire serves as an index of physical and emotional well-being as they are influenced by physical and social conditions at work. Responses to items in this checklist are linked to environmental conditions to identify poor health outcomes associated with these conditions.

4) Employee Attitudes
This questionnaire investigates each employee's thoughts and attitudes about his or her specific work station and the office environment in general. Associations between environmental features and workplace attitudes can suggest workplace redesign that might stimulate positive attitudes toward the environment and perhaps the organization.

5) Demographic Information
The demographic information is used to assess responses of subgroups within the office being studied. These subgroups may have specialized experiences and needs with respect to the work environment.

Situations Where Used The new sophistication about the importance of facilities design and management within organizations has led managers to become more interested in research strategies for evaluating the health and economic impacts of physical changes in the workplace (Stokols, 1986). Many of the research methods reported in the scientific literature are being applied within organizations to assess current inefficiencies and possible improvements in the physical design of the workplace. Diagnostic surveys of employees' opinions about their work environments, in particular when related to objective measures of the environment (e.g., noise, temperature, light) can serve as criteria for evaluating how well an office facility supports an organization.

Advantages The UCI method includes clear guidance on how to communicate with respondents regarding the benefits to the respondents and the subjects' rights and welfare. For example, voluntary subject participation is a condition set by the UCI research team. Respondents have access to reports of summary data and only aggregate results are reported to assure that no individual can be identified.

Limitations This relatively new survey is still under development. Although preliminary results have proven to be

valuable for facility management, the longitudinal studies must be completed to establish the reliability and validity of the method. This survey incorporates five or more different questionnaires covering several facets of employee performance (e.g., time loss estimates associated with specific environmental problems; locations of employee activities within the building; employee health, satisfaction and demographics). For appropriate interpretation of the interrelationships among the data from these different questionnaires, extensive data coding, entry and analysis is required. Eventually, the questions and initial analysis may be standardized.

Procedure The survey Project Manager would introduce the questionnaires, answer questions, collect returned survey forms, and oversee the coding and analysis of the data. Depending on the objective of doing the survey, different questionnaires may be use. The following describes the five questionnaires used by PWC.

Ratings of Environmental Features The Ratings of Environmental Features (REF) is a seven-page questionnaire listing 46 features of the existing facilities. For each item, participants are asked to evaluate the environmental feature on a 7-point scale ranging from "excellent" to "very poor," and "not applicable." The participants are then asked to identify key hassles frequently associated with that aspect of the environment and to estimate the average minutes-per-day, or per-week, of productive work-time lost as a result of dealing with those hassles.

As this questionnaire covers a wide range of physical conditions within the workplace, it is a useful index of employees' impressions about the environmental quality of their office. The survey also reveals which aspects of the environment employees rated most favorably or unfavorably, and which environmental problems are identified by employees as being associated with the greatest loss of productive work-time during a typical work day.

An analyses of the REF data is summarized in three tables. The first table contains the average rating for each of the environmental features included on the survey. The features are grouped according to how favorably they were rated by the respondents. The number of respondents rating each feature is indicated for each item, next to the mean rating. Ratings of "not applicable" are excluded from the mean rating and from the number of respondents.

Two approaches are used to interpret respondents ratings of environmental features. The first is to

consider the severity of complaints about a particular feature, and the second approach examines the prevalence of complaints. The relative severity of environmental problems are assessed by two related measures from the REF questionnaires: 1) the average rating of quality associated with different features listed on the survey, and 2) the magnitude of time-loss associated with each of the features. Prevalence is measured by the percentage of respondents within a Branch indicating that they lose productive work-time each day due to a specific feature of the environment. The ratings of environmental features is used as a diagnostic tool to make relative and comparative evaluations. Neither the ratings nor the time-loss estimates are used as absolute measures.

The results presented from the REF provide insight about the order in which repair jobs or maintenance tasks should be done. It is recommended that these decisions be made in consultation with individuals from the group affected by the environmental problem. The approaches are:

1) attend to major problems that affect a lot of people (that is, ratings in the POOR range with more than 8 minutes lost per day, reported by more than 25% of respondents);
2) attend to major problems that affect some employees (that is, the ratings in the POOR range with little time-loss reported (between 3-8 minutes), reported by less than 25% of respondents);
3) attend to environmental features that are not problems in themselves but because of location, arrangement, or availability, cause major time-loss for some staff members; and,
4) attend to environmental features that are neither serious problems nor responsible for major time-loss, but detract from the quality of the work environment.

Employees' estimates of productive work time (in minutes) lost each day due to the hassles associated with specific features of the work environment are determined as follows. Estimates given in minutes-per-week are converted to minutes-per-day, assuming five work days per week. The "Sum of estimated time-loss" represents the mean (average) total time-loss estimated by the participants. Individual environmental features are then grouped according to how frequently they are mentioned as a source of time loss by the survey participants. These average estimates are based only on the responses of those participants who specifically wrote in a non-zero time-loss estimate.

Time-loss estimates may be difficult for individual employees to estimate for several reasons. First, the

actual time-loss may vary substantially during a typical work week. Second, it may be difficult to distinguish the varying degrees of time-loss associated with a number of different environmental features simultaneously. Third, except for extremely routine tasks, most office workers may not think of their work as taking place in thirty second or one-minute blocks. Yet it is often the nearly undetectable time-loss experienced by a large number of employees several times a day that can contribute substantially to environmental inefficiency.

Several procedures have been implemented to address these problems during both survey administration and data analysis. The instructions to participants discuss the problems noted above. In addition, typical examples of office problems are selected to illustrate minimal time-loss, (e.g., standing in line for one minute to use the photocopier).

In the data analysis phase, three procedures are used to control for extreme time-loss estimates. First, participants estimating exceptionally large amounts of time-loss are excluded from the analyses of time-loss. For the present analysis, participants estimating a total time-loss in excess of three hours are excluded from further consideration. Second, no estimate is permitted to exceed thirty minutes per day for a single environmental feature. These manipulations of the data are not based on normative standards. Rather the time-loss estimates have been reduced to control for some of the difficulties participants experience in making these estimates. Finally, the resulting time-loss estimates are treated as diagnostic and comparative. It is more important to examine patterns of time-loss than to decide whether a particular environmental feature is associated with a ten- or five-minute per day loss per employee.

Location of Work Activities This is a three-part survey designed to assess the following: time spent in different work areas (i.e., own desk, other branch); time spent in specific areas of the building and the number of trips taken to these areas; and the extent of specific equipment use (e.g., computers, telephone, microfiche).

In all three sections, employees are asked to estimate the number of hours spent in specific areas or doing specific tasks. It may be difficult for respondents to judge the exact hours spent in specific location, however it is the general pattern of space use for an individual or group that is most important. Understanding the general location of an employee's activities helps identify the actual environment that the employee is experiencing. While most employees

will be assigned a desk, the extent of time actually spent working there will vary greatly from person to person. Using this information in conjunction with the Ratings of Environmental Features, Checklist of Work-Related Experiences, Employee Attitudes surveys, and available architectural, engineering and building diagnostic information, clarifies the patterns of responses emerging from these surveys.

Checklist of Work-Related Experiences The Checklist of Work-Related Experiences (CWRE) is a two- page questionnaire listing 35 physical, emotional, organizational and environmental experiences of the workplace. For each item, participants are asked to estimate the relative frequency of the work experience on a 5-point scale ranging from "always" to "never.

The CWRE is a useful indicator of the frequency of day-to-day events in the workplace. Both positive and negative experiences are tapped. When correlated with subjective ratings of the physical environment (e.g., the Ratings of Environmental Features), the CWRE functions as a diagnostic tool for assessing the environmental and organizational features of an office.

The data is analyzed and summarized in tables which indicate the average (mean) frequency of the 35 work-related experiences included in the CWRE survey. These experiences are grouped into two categories: positive and negative. A high mean score for a positive experience is desirable, whereas a high mean frequency for a negative experience may signify a problem in the workplace. Next to each mean frequency is the number of respondents for each item. Items left blank by individual participants are not included in mean frequencies or number of respondents.

Employee Attitudes The Employee Attitudes questionnaire is a three-page survey designed to assess employees' general attitudes about the building, organization, and fellow employees. In addition, attitudes about current computer use and support, and feelings about the upcoming automation were included. All questions (except those assessing computer adjustability) are scaled from 1 to 5. The anchors differ from question to question (e.g., "not at all" to "a great deal", or "not at all satisfied" to "very satisfied") but remain consistent in direction (i.e., the higher the number the more positive the attitude).

This questionnaire is used as an indication of general satisfaction, and for comparison to the specific ratings in the Ratings of Environmental Features and the Checklist of Work-Related Experiences.

Demographic Information Demographic information is most important as a source of statistical control. Most of the information collected is for analytical use in conjunction with the other surveys.

Information about computer use, access, and experience was drawn from both this survey and the Employee Attitudes. This information can help guide decisions concerning automation of office functions.

Validation of Method UCI follows procedural guidelines to develop valid and reliable assessments of the relationships between facilities design, employee productivity, and organizational effectiveness. These guidelines include:
1) The use of multiple measures of employee performance and organizational effectiveness (e.g., individual estimates of productive time loss due to an aspect of the environment, workers ratings of their physical and emotional well-being, records of production rates and absenteeism).
2) Objective (direct environmental observation) and subjective (employees ratings of the workplace) measures are correlated.
3) Assessment of physical conditions are examined in relation to multiple measures of organizational structure and the social culture at work. The combined influence of the physical, social, and organizational dimensions of the work setting affects the employees productivity and well-being.
4) The relationship discussed in point 3) above should be examined several times over repeated intervals rather than at a single point in time. Longitudinal studies demonstrate the impact of organizational and environmental changes on employee productivity and well-being.
5) Facilities evaluations and productivity assessments are inherently political processes (and are not socially "neutral" events). Politically-sensitive issues to be addressed include: employees' concern for the confidentiality of their responses; managers' concern that the study may raise unrealistic expectations among employees; facilities management concerns when the survey reveals conflicting opinions on building performance; the art of translating survey findings into recommended action.

2.2 Short Instrument

The Short instrument is the result of several years of work and a series of developmental projects initiated by the Architectural & Building Sciences Division (since dissolved) of PWC. Several consultants contributed to the development of this approach to occupant survey including, Dr. John Zeisel, Pleasantine Drake, and Polly Welsh. The current refinement of the Short questionnaire was done by consultants (Drs. Dillon & Vischer) under contract with the Building Performance Division, Technology Branch, A&ES, PWC. Several documents were produced under this contract and their content will not be repeated here (see Section 4. References). Rather, the following summarizes the main points of this method and groups them into the standardized headings used in this section.

Principle Features of the Short Method The Short questionnaire is promoted as a simple approach to assessing occupants' ratings of office building performance. The method compares the average rating by occupants to a "norm" derived from other buildings previously rated by occupants using approximately the same instrument.

Situation Where Used This instrument may be used in response to complaints by occupants regarding an aspect of the interior environment.

Advantages All aspects of this insturment are convenient to use. As it is only two pages, copying and distribution are quick. Respondents usually complete all of the 24 questions and it is expected that the majority of questionnaires will be returned (i.e., a high rate of return). Computer coding of the 24 questions is a small task, and the statistical analysis is quick.

Limitations Despite the efficiency of using this questionnaire, it may not provide sufficient information to confidently guide facility management. The instrument seems to ask the wrong questions of occupants for the purpose of guiding and prioritizing facility management actions.

Procedure A standard questionnaire of 2-pages is used, regardless of specific conditions of any given building under study (e.g., age, construction type, known problems or a "good" building). Occupants are asked to rate how certain aspects of the building interior affect their comfort and

satisfaction at work. The ratings are compared to a norm that is derived from average ratings from previous building surveys, which are stored in a computer database. The results of the comparison indicates whether the building is performing within the same range as other office buildings or whether there are any aspects the require further investigation or action.

Validation of Method The contractors do not relate this method to proven survey techniques or standard research designs. As there have been only a couple of field trials with this survey the method has no proven track record of its own and it cannot rely on established methods because none are cited in the documentation. It is not clear or convincing the this is a valid method. PWC should not use it widely until it has proven to be valid and of benefit.

2.3 Delphi Instrument

Delphi is a method to solicit, collect, evaluate and tabulate independent opinion without group discussion. This method was introduced in the 1950's by the RAND Corporation, California's prestigious think-tank. Initially it was applied to military problems with other applications being developed since the 1960's.

The name Delphi comes from Greek mythology and the most celebrated of the Grecian oracles who came from the city Delphi. Oracle was the name used to denote the place where answers were supposed to be given by any of the divinities to those who consulted them respecting the future. The geographic location of the city of Delphi was also important. The Greeks believed the world was flat and circular with their country occupying the middle of it and the central point being either Mount Olympus (the abode of the gods) or Delphi, so famous for its oracle.

Principle Features of The Delphi Method The objective of the Delphi method of forecasting, classic and modified, is to make the widest possible use of the knowledge and experience of an organization. It achieves a decision by consensus with anonymous collaboration, through the distribution of questionnaires to a multi-level, multi-individual group of respondents.

The distinguishing feature of the questionnaires is anonymity. This eliminates confrontation of experts as no person is inhibited from expressing his or her viewpoint simply because higher level persons are on the panel. This quasi-objective questionnaire technique replaces direct debate.

The systematic feedback of results of several round of questionnaires to participants serves as a record of the basis for making major decision. Participants keep their responses for comparison against the trends, allowing them to see the relevance of their scores to the trends. This self-scoring capability allows participants to benefit and learn from the analysis.

For example, in the application of Delphi in the area of building diagnosis, the target audience may be is the community of developers, architects, engineers, and property managers. A self-profile capability, that is to rate themselves against the competition, is desirable. Also of interest is guidance as to where their profile misses or matches the distribution.

If tenants had completed the survey, they would be given the distribution or central tendency of the results. Managers receive the diagnostic survey (the interpretation of the results) and can cross check their "reality" with that of the tenants by comparing responses to the same completed questionnaire.

Situations where used The Delphi method is well suited to issues requiring wide and representative input. This includes situations with a large number of participants with diverse views where no individual has sufficient expertise and knowledge to affect a solution. The method is used for long-range technological forecasting to predict likely inventions, new technologies and product applications. It is not appropriate for routine decision-making.

Delphi questionnaire analysis provides an "attitudinal net worth" in the accounting sense (as opposed to the statistical meaning such as analysis of variance). This balance sheet approach, akin to a fund flow statement, explains the changes observed (inter-period comparison).

Landlords are often blamed for conditions beyond their jurisdiction. A "fishing expedition" type of questionnaire can determine if this is happening and over which issues. A sample questionnaire theme (of which there can be many) could be "to improve the tenants' esteem for the landlord". This may be probed by telling the respondent "you said that the average temperature was too hot in winter. We measured the temperature over several days in winter and found that it averaged 20^{o}C (ranging between 16-25^{o}C). At the same time we noted that the relative humidity was only 20-25%. Does that modify your view of your environment?" The respondents are never asked what the average temperature is per se.

Futures research, also referred to as social forecasting, is another application for the Delphi method. An example of this work is in education with the design of a new curriculum, and the prediction of its impact on socioeconomic development on future school systems. In these types of application, interactive polling and feedback are unnecessary to predict the probability of occurrence for an event but are sufficient to decrease group forecast error to the level of the best panel member.

Advantages The Delphi method eliminates bias in people's responses by keeping the identities of the participants unknown and minimizing negative group dynamics. There are no emergent leaders based on high status, expressive, or strong individuals. The "halo effect" where one highly respected

individual influences others, or the "bandwagon effect" which encourages agreement with the majority are eliminated. Anonymity is achieved through questionnaires, evaluated and scored by someone completely removed from the decision. Thus, this approach is likely to produce more accurate results than the open committee approach.

Participants are not required to be in a common location so the group can be larger and the cost of the survey lower. The Delphi group process can be useful to disseminate information and provide instruction. Experts respond to this information and reach a consensus based upon relevant information. Experiments with the Delphi method have shown that a consensus can be achieved if there is a common good served by agreement (Love, 1975).

Limitations The crucial step to the success of a Delphi round is the selection of participants. How to select participants is discussed in the Procedure section.

The time to complete the iterations in a classic Delphi can be considerable. A three round Delphi can take several weeks. If results do not come quickly, participant motivation wanes.

The modified technique developed by Arthur Gillman of Delphi Consultative Ltd., telescopes the time required by deepening and shortening the framing and positioning of responses. This is an alternate analysis to the successive iterations of the classic Delphi. This modified Delphi is more akin to a town hall meeting than a survey. Respondents photocopy their responses so they can see their relevance to the trends (central tendency). The direction of an option is positioned on a 10-axis graph (mathematically constructed, represented by a beta coefficient) and tells the respondent if their choice is good, bad, new, relevant, etc.

Procedure Two groups are involved in a Delphi:

Group 1: Decision makers who must act on the conclusions of the study

The effectiveness of a decision equals the quality of a decision times the acceptance of a decision. It is better accepted if the people who are affected by the decision are also involved in reaching it.

Group 2: Selected panel of experts whose judgments are being sought

The people whose judgments are being sought must agree to answer the questionnaires. Criteria for selecting experts:
- must have basic knowledge of problem area;
- good performance in their particular area;
- high degree of objectivity and rationality;
- have time available; and
- must be willing to give the amount of time and effort required (n.b., the modified Delphi relaxes this requirement).

Staff members are professions who conduct the Delphi process. Their functions include: interview each decision maker; determine what information should be obtained from experts and how that information will be used (these are important stages and are time consuming).

The staff member or person who chose the panel should convey:
- the purpose of the study;
- the primary question or problem;
- the part the panelist will play in reaching a solution;
- the importance of a concerted effort on their part to the success of the results; and
- the uniqueness of their abilities in the total effort.

The composition of the panel will vary with the nature of the problem. For highly specific and technical problems, respondents should have technical expertise and the panel must have a proper balance of theoreticians and pragmatists. Every panelist need not have the know-how to solve all aspects of the problem, but the collective experience should be more than enough to cover every facet of the problem.

If the group is homogeneous, then a group of 10 to 15 is sufficient. As homogeneity declines a larger sample is required for quality results.

The classic Delphi process is divided into at least three stages with each stage representing an analysis of the preceding one. The first questionnaire is designed to discover the basic position on previously defined objectives. The second questionnaire allows a consensus to form and the third questionnaire establishes the major consensus.

Each stage uses a questionnaire. There are two conceptual approaches to the development of the first questionnaire.
1) state the problem, issue, or question in specific terms, with the greatest detail feasible. Each response contains one opinion.
2) state the problem, issue, or question in general terms, requiring further specification. Questions contain one or

more open ended questions to better define the problem.

Questionnaires are distributed with self-addressed, stamped envelope for returning responses. A due date is clearly stated.

Participants are free to change their views and ratings in the iterations. Individuals are asked to request any information they need. Information can be distributed which may aid others in the decision process.

Following tabulation of questionnaires, each participant is given the results, usually trends (central tendency). The tabulations show areas of agreement and disagreements thus identifying items requiring clarification or additional information. This also creates the material for the next questionnaire. Respondents are sent explanation of any misconceptions on the part of respondents and each is asked to revise his or her opinion based upon new data and response of peers. Views significantly out of step with the consensus are asked to be justified.

The purpose of information feedback in the iterations is to produce more precise predictions and to encourage opinion convergence. Panelists can objectively assess the central values of the other panelists in regard to their own, and objectively consider the reasons for being higher or lower than this range. Then, they can make a private, unimpassioned, and objective assessment for their next opinion. They can move off previously established positions without any loss of ego, because no one knows whether they do it or not.

The optimal number of questionnaire rounds of traditional Delphi for a group to reach stability is four (Erffmeyer, et.al.,1986). Factors affecting the appropriate number of iterations include: composition of the participant group, the nature of the problem, and the types of feedback provided to participants.

Validation of Method The accuracy of predictions, however generated, is difficult to test when events will occur in the far future, however there are two approaches for validation:
1) compare Delphi predictions with actual occurrences.
2) compare Delphi predictions with those of conventional confrontation methods.

Using the first approach, a study of 8 groups of 20 people satisfactorily predicted 32 out of 40 short range questions in a two round Delphi (Parents, et.al., 1984).

Using the second approach, Delphi predictions were more accurate in 13 of 16 cases, less in 2, equal in 1 (Parents, et.al., 1984). Results from Delphi rounds were compared to nominal group techniques for the following activities: structured meetings, written suggestions, round robin presentations, idea discussion, and voting on ideas. Six Delphi questionnaires were sent to 49 experts and produced more detailed information and elaboration on issues. The nominal group technique was more efficient at identifying major topics but the Delphi was twice as efficient in eliciting, describing and amplifying issues (Salasin, et.al, 1981).

The available forecasting techniques use subjective modeling and rely on managers' intuition and informal judgement. This is both risky and unreliable as executives tend to assign a low priority to events likely to occur far in the future due to their concern for more immediate problems. Structural models use math and time-series models (regression, smoothing, Box-Jenkins) to represent cause-effect relationships. These provide useful information but the models have serious drawbacks which reduce their reliability (Chan, et.al, 1980).

Risk simulation, the estimation of adequate probability distribution for the variables, is the most difficult part of future planning. The probability of an event can be determined by exact calculation, past data, or subjectively using one's own judgment. The most successful methods for estimation of subjective probability distributions have been probability assessment, fractile assessment, and the Delphi method (Ewing, 1979). Only when the performance measure is very sensitive to the variable in question would one of these methods be used.

Delphi appears to be at least as good to other long-range forecasting techniques. Group predictions were more accurate than 95% of individual panelists but did not exceed the best panelist in accuracy. The group's ability to forecast the probabilities of an events occurrence was unimproved however the error in predicting when the events would occur decreased (Milkovich, et.al. 1972).

Technological forecasting models use logical analysis to predict technological developments. Delphi is the best known of the over 150 forecasting techniques available, although only about 12 are widely used. These include: trend extrapolation; trend impact analysis (TIA); scanning; monitoring; the Delphi technique; cross-impact analysis; computer simulations; scenario writing; and technology assessment. A new approach was introduced in 1974 by the

Office of Technology Assessment, USA called Ideological Matrix Prediction (IMP).

2.4 Virginia Polytechnic Institute (VPI) Instrument

The work underway at VPI is aimed at statistical sampling in large buildings to do quantitative performance assessment. The project is partially supported by a grant from the National Science Foundation, USA (Grant No. MSM-8420540) and began in 1985. The principle investigators at VPI are Dr. Francis Ventre, Professor of Architecture & Building Construction, and Director of the Environmental Sciences Laboratory, and Dr. Prabhakar Ghare, Associate Professor of Industrial Engineering and Operations Research. The objective of the project is to devise efficient methods for describing environments in large buildings. The project is structured to devise the method for evaluating the environmental performance of large buildings and is not designed to evaluate the performance of any given building. The VPI method is a descriptive tool, not a design tool.

Principle Features of the VPI Method Criteria of prime importance for the method being devised are scientific soundness and field practicabiiity. The method will describe the characteristics of a designed environment and highlight the differences from intended design. The current research is focused on independent variables (aspects of the environment). However, as environmental performance seems to relate to organizational aspects such as employee absenteeism (leave, sick, etc.), the dependent variable of human perception will be included in future work.

Situation Where Used The method is designed for use in large buildings (greater than 4,700 m^2 (50,000 ft^2)). It is used as a diagnostic screening for buildings. It will provide summary statistics as indicators of overall building performance. The survey is will not be overly detailed or exhaustive.

The spatial quality control in buildings is the weakest area of facility management. In response to this, the VPI method focuses on spatially distributed performance attributes versus pure physical characteristics. These are plotted as contours, connecting points of equal value. VPI has named these contours "ISOPERF" from the Greek "iso" meaning equal value, and "perf" as a shortened form of performance.

Advantages Whenever a sample of a population is used, there will be some error. A standard response to reduce fluctuations from sampling error, is to increase the number in the sample (the higher the variability, the larger the sample; the lower the variability, the smaller the sample).

However, this also increases the cost. Although the VPI method may be a "general purpose" instrument, the sampling strategy is smarter about measurement and variance of data. Thus it has the potential to be a more efficient way to describe buildings.

The performance of environmental aspects in a building are highly variable. Assumptions are made in several test procedure to generalize the measurement. However, the simplification of the environmental phenomena can make the result meaningless or wrong. For example, acoustical sensations is assumed to be symmetrical but it is not. Because local deviations in environmental performance are of interest and value to a study, the VPI method employs nonparametric statistics (e.g., building performance variation and rough distribution; Bon Ferroni test to tell how the shape of the distribution varies; normal distribution when applicable, Weibul test; log log distributions).

Limitations As with any assessment of building performance, it is difficult to describe certain environmental phenomena. Standard measurement procedures and target values often vary from organization or country. For example, for the past 25 years ASTM (the American Society for Testing and Materials) has had a committee working on standardizing what is meant by room noise and how to measure it. This is not a limitation of the VPI method per se. However, without benchmarks against which to assess the levels measured in the field, it is difficult to cross-related findings or rank buildings by their performance.

Procedure The researchers have published several papers on this work (see Section 4. References) and the procedure can be read from the source. The first step of the work involved creating a theoretical model based on environmental criteria which would select locations within a building for sampling. Performance data from three buildings was used to estimate what happens in buildings. Public Works Canada data from the Harry Hays building in Calgary, the Department of Communications Field Trial in Ottawa, and the Revenue Canada Taxation Center in Winnipeg were provided to VPI for this exercise. Next, independent measures of a building were made by a field team from VPI. Presently, the data is being analyses and the model's accuracy is being verified.

Validation of Method Presently VPI is validating the theoretical model prepared in the first stage of this work. They are doing experimental statistical runs using different

sample locations to determine if the sampling strategy would produce a set of locations truly representative of the total building. The work is in progress.

3.0 FUTURE WORK

Each method presented in this report has an appropriate use which will depend on several factors including the needs of the client, the budget, and the political situation. The major difference in approaches is the tradeoff of short-term brevity for long-term benefit. Specifically, the efficiency advantage of the Short questionnaire is quickly outpaced by the value of the interrelationships of factors which can be established by the UCI or Delphi questionnaires.

Additional field work is required with all these methods and none are sufficiently developed to be used for a wide reaching survey. PWC should not consider offering its Regions a diagnostic survey of all or many of the buildings in its portfolio. The majority of facility managers will greet the idea of using a tenant survey to guide or prioritize building repairs with some skepticism. These instruments are not ready for such scrutiny.

GRAS sponsored a related project named "Questionnaire Database Review", No. 602060, Project Manager: A.W.Cunningham. The project description in the "Directory of Projects 1987-88" stated that the "contractors are now developing a document on expert methods and analysis, and a simplified model questionnaire and guide for regional use". As previously stated, this method has no proven track record and the results from the field test have not convincingly show this to be a valid method. PWC should not use the Short questionnaire widely until it has proven to be valid and of benefit.

In fiscal year 1988-89, it is recommended that PWC develop occupant questionnaires along the lines of the UCI instrument. PWC and UCI have established an agreement to cooperate on facility questionnaires (letter R.Davidge to W.Selufsky, UCI, dated January 25/87). This allows for collegial communication and discussion of ideas, opportunities, or difficulties. This does not require a contract with UCI as each organization is responsible for the expenses of their respective staff.

3.1 Authority to Collect "Personal Information"

PWC needs approval to collect "personal information" when distributing the building environment questionnaires. Statistics Canada defines personal information as "information about an identifiable individual that is recorded in any form". To target recommendations to specific locations, either the respondent's name or his or her desk location must be known. As well, building

environment surveys may contain health related questions which may be viewed as "personal information".

A process to secure the required approvals to collect "personal information" with building environment questionnaires has been underway since September/87. As approvals are required from both Treasury Board and Statistics Canada this is a lengthy process. It is anticipated that approval will be confirmed by March 31/88.

A Treasury Board form "Personal Information Bank Registration" (# SCT 350-84(85/1)) was completed and reviewed by John Dickinson, PWC's coordinator for Statistics Canada. This form (in english and french) was officially submitted to obtain approval in February/88. At the writing of this report, this approval was still in progress.

The survey instruments (UCI and Short) were submitted to Statistics Canada in September/87 to ensure that the questionnaires conform with the requirements of Treasury Board Circular 1986-19 "Government Information Collection and Public Opinion Research". A letter from C. Lyon (Head, Federal Information Collection Group, Statistics Canada) to A. Kaplan (Project Manager, Statistical Methods Project, PWC) dated November 16/87, approves the survey instruments (Stats Canada File No. 87/2948/DPW).

3.2 Other Methods and Approaches

Survey companies in Canada may offer other methods for assessing occupants' perception of building performance. Although no work in this area was readily available, it would be worth further inquiry. A short list follows.

McKinsey: The largest management consulting firm in Canada and does international work.

Goldfarb, Toronto: This company does the polling for the conservative party. The manager is Allen Gregg (formerly of the polling company DECIMA).

Gallup Canada: The company is run by the founder's son (Gallup Jr.). The work has tremendous integrity, and is applied internationally. Compared to advancements in the field of polling, the work is methodologically pedestrian and the company is highly bureaucratized.

A person's perception of his or her environment is a multidimensional process. As such, it is intriguing to investigate models for 3D mapping of environments. There are several emerging technologies and software for this type of mapping which fall generally in the area of automated facilities mapping (AFM). An overview of these systems was provided in a meeting with Bruce Joffe, of BSI Consultants, California. The AFM would serve as a 3D map where several different bits of information about a space would be stored along with the perceived environmental ratings of the occupants. Such a database would increase the speed and accuracy with which building performance data could be analysed and transformed into facility management actions. Although exploring this avenue was beyond the scope of this project it merits consideration for future work. Reference is made to a project managed by Roger Henry dealing with automated facility management software (GRAS Project No. 602040 "Automated Facilities Management", 1987-88).

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QUESTIONNAIRE 1
RATINGS OF ENVIRONMENTAL FEATURES

1. Please rate each of the following features of your present work environment on a six-point scale, ranging from "excellent" (6) to "very poor" (1). If a particular feature is not applicable to the work that you do, please rate this feature "not applicable" (N/A).

2. Then, for all those environmental conditions that are applicable to your work situation, please estimate the amount of productive work time (in **minutes** per day) that is lost due to that aspect of the environment.

   a. If no time-loss is experienced with respect to a particular environmental feature, please indicate "0" minutes.

   b. We would prefer that you estimate time-loss in **minutes per day**. However, if it is more convenient for you to estimate time-loss by the work week for a particular feature, please use the **minutes per week** space provided.

   c. If time-loss from two features of the environment cannot be separated, divide the time-loss in half and indicate this estimate for both items.

   d. Be careful that the total time-loss for all items does not exceed the hours worked in a typical day.

3. Finally, on the right, please note any negative impacts on individual or team performance that are associated with each feature of the environment. (Examples of negative impacts on performance are reduced concentration and creativity, feelings of fatigue or strain, increased frequency of errors, inability to locate needed materials, duplication of effort, missed deadlines, misunderstandings or conflicts among co-workers, high rates of absenteeism and staff turnover.)

4. Use the blank boxes at the end of this questionnaire to identify and rate additional environmental features not included in this survey.

RATINGS OF ENVIRONMENTAL FEATURES

Environmental Feature	Your Rating of Each Feature: Excellent 6	Very Good 5	Good 4	Fair 3	Poor 2	Very Poor 1	Not Applicable N/A	Productive Work Time Lost: (Put 0 if no time lost)	Examples of Negative Impacts on Individual and Group Performance Resulting from this Feature of the Work Environment
1. Quality of lighting for the work you do	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
2. Brightness of the lighting for the work you do	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
3. Overall air quality in your work area	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
4. Ventilation and air circulation in your work area	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
5. Quality of air conditioning	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
6. Quality of heating	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
7. Comfort of your chair	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
8. File storage space to suit your work requirements	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
9. Convenient access to reference materials	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	

RATINGS OF ENVIRONMENTAL FEATURES (continued)

Environmental Feature	Your Rating of Each Feature: Excellent 6	Very Good 5	Good 4	Fair 3	Poor 2	Very Poor 1	Not Applicable N/A	Productive Work Time Lost: (Put 0 if no time lost)	Examples of Negative Impacts on Individual and Group Performance Resulting from this Feature of the Work Environment
10. Worksurface space to accommodate office machines and reference materials	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
11. Desktop and work surface space to accommodate the work you do	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
12. Availability of book shelves in your work area	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
13. Overall noise control	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
14. Conversational privacy within your office	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
15. Visual privacy within your office	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
16. Lockable storage area for personal items	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
17. Availability of marker boards and other display surfaces	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	

RATINGS OF ENVIRONMENTAL FEATURES (continued)

Environmental Feature	Your Rating of Each Feature: Excellent 6	Very Good 5	Good 4	Fair 3	Poor 2	Very Poor 1	Not Applicable N/A	Productive Work Time Lost: (Put 0 if no time lost)	Examples of Negative Impacts on Individual and Group Performance Resulting from this Feature of the Work Environment
18. Access to enclosed conference areas	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
19. Availability of shared work space for team projects	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
20. Distances between co-workers' offices	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
21. Distances between major departments in your building	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
22. Efficiency of layout in your building	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
23. Overall access to office equipment	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
24. Access to word processors	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
25. Access to typewriters	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	
26. Access to photocopiers	6	5	4	3	2	1	N/A	____ min./day **OR** ____ min./week	

RATINGS OF ENVIRONMENTAL FEATURES (continued)

Environmental Feature	Your Rating of Each Feature: Excellent 6	Very Good 5	Good 4	Fair 3	Poor 2	Very Poor 1	Not Applicable N/A	Productive Work Time Lost: (Put 0 if no time lost)	Examples of Negative Impacts on Individual and Group Performance Resulting from this Feature of the Work Environment
27. Access to microfiche or microfilm readers	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
28. Availability of electrical outlets	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
29. Capabilities of your phone system	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
30. Availability of a separate waiting area for visitors	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
31. Availability of interview rooms	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
32. Aesthetic quality of your office	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
33. A place to work that is free of distractions	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
34. A place to go where you can relax	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
35. Ability to adjust your office furniture as your job changes	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	

RATINGS OF ENVIRONMENTAL FEATURES (continued)

Environmental Feature	Your Rating of Each Feature: Excellent 6	Very Good 5	Good 4	Fair 3	Poor 2	Very Poor 1	Not Applicable N/A	Productive Work Time Lost: (Put 0 if no time lost)	Examples of Negative Impacts on Individual and Group Performance Resulting from this Feature of the Work Environment
36. Adjustability of your lighting as your job changes	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	
37. Overall control of lighting for video display units	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	
38. Ease of movement in hallways and walkways	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	
39. Availability of plants and other natural features in your work area	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	
40. Sufficient enclosure of your work-station (e.g., walls, screens) for the job that you do	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	
41. Efficiency of the elevator system in your building	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	
42. Convenient access to restrooms	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	
43. Cleanliness of restrooms	6	5	4	3	2	1	N/A	____ min./day OR ____ min./week	

RATINGS OF ENVIRONMENTAL FEATURES (continued)

Environmental Feature	Your Rating of Each Feature: Excellent 6	Very Good 5	Good 4	Fair 3	Poor 2	Very Poor 1	Not Applicable N/A	Productive Work Time Lost: (Put 0 if no time lost)	Examples of Negative Impacts on Individual and Group Performance Resulting from this Feature of the Work Environment
44. Quality of building maintenance	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
45. Insect and rodent control	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
46. Aesthetic quality of interview rooms	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
47.	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
48.	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
49.	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
50.	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	
51.	6	5	4	3	2	1	N/A	_____ min./day **OR** _____ min./week	

QUESTIONNAIRE 5
DEMOGRAPHIC INFORMATION

1. PLEASE DESCRIBE YOUR PRESENT POSITION.

   a. Your job title: _____

   b. Please check the category that best describes your position.

   _____ Support Staff: clerks, secretaries, junior administrative assistants.
   _____ Knowledge Workers: professionals, technicians, officers, senior administrative assistants.
   _____ Managers: individuals who direct, manage and/or supervise others at work. The job usually involves a considerable amount of administrative and supervisory duties.
   _____ Executives: individuals who are responsible for planning organizational policies and seeing that the overall objectives are met in an appropriate manner.

   other: _____

2. IF YOU ARE IN A SUPERVISORY ROLE, APPROXIMATELY HOW MANY EMPLOYEES DO YOU SUPERVISE?

   _____ number of employees that you supervise _____ not applicable

3. YOUR BRANCH OF REVENUE CANADA – TAXATION:

   _____ Appeals

   _____ Audit
   - _____ Audit Review
   - _____ Business Files
   - _____ Basic Files
   - _____ Tax Avoidance
   - _____ Electronic Data Processing
   - _____ Special Investigation
   - _____ Real Estate Appraisals

   _____ Verification and Collections
   - _____ Enquiries and Office Examination
   - _____ Collections
   - _____ Source Deductions

   _____ Administration and Support
   - _____ Internal Audit
   - _____ Forms Distribution

   _____ Personnel

4. YOUR USUAL WORK DAYS, (circle all that apply):

SUN MON TUES WED THUR FRI SAT

5. THE TIME OF DAY YOU TYPICALLY:

start work _____ leave work _____

6. HOW LONG HAVE YOU WORKED:

a. in your present position:

_____ years _____ months

b. at Revenue Canada:

_____ years _____ months

7. HOW OFTEN DO YOU USE A COMPUTER:

at work	at home
_____ very often	_____ very often
_____ often	_____ often
_____ sometimes	_____ sometimes
_____ rarely	_____ rarely
_____ never	_____ never

8. HOW LONG HAVE YOU BEEN WORKING WITH A COMPUTER?
(for example: at school, work, home)

_____ year(s) _____ month(s) _____ never worked with a computer

9. ABOUT YOUR COMMUTE TO WORK:

a. How do you usually get to work:

_____ personal auto _____ carpool _____ bus

_____ bicycle _____ walk _____ train/subway

other: _____

b. What is the one-way distance you commute: _____ km or _____ miles

c. How long does your commute to work usually take: _____ minutes

10. DO YOU OWN OR RENT YOUR CURRENT RESIDENCE?

_____ own _____ rent

11. HOW LONG HAVE YOU LIVED:

a. in your current residence? _____ years _____ months

b. in the Hamilton area? _____ years _____ months

12. BRIEFLY, ABOUT YOU:

a. your age: _____ under 25 _____ 46 – 55

_____ 26 – 35 _____ 56 – 65

_____ 36 – 45 _____ over 65

b. your sex: _____

c. your educational background (highest completed):

_____ some high school _____ college degree

_____ high school graduate _____ graduate degree

_____ some college

d. marital status: _____ single _____ married or living with partner

_____ widowed _____ separated or divorced

e. Do you wear glasses or contact lenses at work?

_____ yes _____ no (IF NO, SKIP TO NEXT QUESTION)

What proportion of the time do you wear:

glasses:	contact lenses:
_____ always	_____ always
_____ most of the time	_____ most of the time
_____ some of the time	_____ some of the time
_____ once in a while	_____ once in a while
_____ never	_____ never

13. ABOUT HOW MUCH TIME DID YOU SPEND ON THIS SURVEY?

_____ minutes

14. SURVEY COMPLETION DATE: _____

Finally, please tell us if you found any of the survey items confusing, or if there are any important issues that we didn't address. Use the back of the pages in the questionnaire for your comments. Number your comments if they address specific questions. If any questions occur to you, please do not hesitate to write them down. We are interested in all of your comments and questions.

Thank you very much for taking the time to complete this questionnaire.

QUESTIONNAIRE 4
EMPLOYEE ATTITUDE

1. HOW MUCH FREEDOM DO YOU FEEL YOU HAVE TO DECORATE YOUR WORK ENVIRONMENT WITH YOUR OWN THINGS SUCH AS PICTURES, PLANTS, POSTERS, ETC.?

1	2	3	4	5
Almost no Freedom		A moderate Amount of Freedom		A Great Deal of Freedom

2. TO WHAT EXTENT DO YOU FEEL A "SENSE OF COMMUNITY" WHERE YOU WORK?

1	2	3	4	5
Not at All		Some		A Great Deal

3. ALL THINGS CONSIDERED, HOW SATISFIED ARE YOU WITH THE FOLLOWING AREAS OF THE HAMILTON FEDERAL BUILDING:

A. YOUR OWN WORK AREA OR PERSONAL OFFICE:

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

B. YOUR BRANCH'S AREA OF THE HAMILTON FEDERAL BUILDING:

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

C. THE HAMILTON FEDERAL BUILDING IN GENERAL:

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

4. ALL THINGS CONSIDERED, HOW SATISFIED ARE YOU WITH:

A. YOUR JOB AT REVENUE CANADA TAXATION, IN GENERAL:

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

B. YOUR CO-WORKERS:

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

C. REVENUE CANADA – TAXATION, IN GENERAL:

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

5. PLEASE CIRCLE THE NUMBER THAT BEST DESCRIBES HOW YOU FEEL ABOUT THE PLANNED COMPUTER AUTOMATION OF REVENUE CANADA TAXATION (RCT).

A. I DO NOT WANT RCT TO AUTOMATE.

1	2	3	4	5
Strongly Disagree				Strongly Agree

B. I FEEL MY JOB WILL BE EASIER ONCE RCT IS AUTOMATED.

1	2	3	4	5
Strongly Disagree				Strongly Agree

C. I AM CONFIDENT IN MY ABILITY TO LEARN TO WORK WITH A COMPUTER.

1	2	3	4	5
Strongly Disagree				Strongly Agree

6. DO YOU CURRENTLY USE A COMPUTER IN YOUR JOB?

_____ Yes _____ No
(IF NO, SKIP TO QUESTIONNAIRE 5, "DEMOGRAPHIC INFORMATION")

A. DO YOU HAVE SOLE ACCESS OR DO YOU SHARE THIS COMPUTER?

_____ sole access _____ share computer with approximately _____ (number of) people

B. HOW SATISFIED ARE YOU WITH THE TRAINING YOU RECEIVED ON THE COMPUTER EQUIPMENT YOU NOW USE?

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

C. HOW SATISFIED ARE YOU WITH THE USER SUPPORT FOR THE COMPUTER EQUIPMENT YOU NOW USE?

1	2	3	4	5
Not at All Satisfied		Moderately Satisfied		Very Satisfied

D. CAN YOU ADJUST THE COMPUTER YOU USE MOST OFTEN?
SUCH AS:

The keyboard height is adjustable _____ yes _____ no

The screen can be tilted _____ yes _____ no

The screen swivels _____ yes _____ no

The screen has adjustments for brightness and contrast
_____ yes _____ no

QUESTIONNAIRE 3
CHECKLIST OF WORK-RELATED EXPERIENCES

Listed below are several work-related experiences. Please indicate how frequently each experience occurs for you, on the average. Circle the number that best reflects your feelings on the following five-point scale, where 5 = "always", 4 = "often", 3 = "sometimes", 2 = "rarely", and 1 = "never".

Work-Related Experience	Frequency of Each Experience				
	Always 5	**Often 4**	**Sometimes 3**	**Rarely 2**	**Never 1**
1. Feeling excited about my work	5	4	3	2	1
2. Feeling in control of the pace of my work	5	4	3	2	1
3. Feeling energetic at work	5	4	3	2	1
4. Being in good spirits at work	5	4	3	2	1
5. Feeling overworked	5	4	3	2	1
6. Feeling inadequately trained for the work that I do	5	4	3	2	1
7. Difficulties sleeping at night due to worries about work	5	4	3	2	1
8. Headaches while at work	5	4	3	2	1
9. Eyestrain or blurred vision while at work	5	4	3	2	1
10. Soreness in lower back while at work	5	4	3	2	1
11. Soreness in neck or shoulders while at work	5	4	3	2	1
12. Soreness in arms, wrists, or hands while at work	5	4	3	2	1
13. Feeling fatigued at the end of the day	5	4	3	2	1
14. Unrealistic deadlines for paper work	5	4	3	2	1
15. Feeling distracted by too many phone calls	5	4	3	2	1
16. Feeling frustrated by "telephone tag"	5	4	3	2	1

Work-Related Experience	Frequency of Each Experience				
	Always 5	**Often 4**	**Sometimes 3**	**Rarely 2**	**Never 1**
17. Not knowing how to find key information and reference material in the office	5	4	3	2	1
18. Wasting time by repeating tasks unnecessarily	5	4	3	2	1
19. Opportunities for open exchanges of ideas with my supervisor	5	4	3	2	1
20. Supportive interactions with my co-workers	5	4	3	2	1
21. High levels of employee morale	5	4	3	2	1
22. Feeling confused about my responsibilities on a project	5	4	3	2	1
23. Feeling confused about project schedules	5	4	3	2	1
24. Feeling confused about project budgets	5	4	3	2	1
25. Conflict with co-workers about project priorities	5	4	3	2	1
26. Insufficient guidance from supervisor	5	4	3	2	1
27. Difficulties in contacting supervisor	5	4	3	2	1
28. Difficulties in contacting co-workers	5	4	3	2	1
29. Opportunities to participate in decisions about the projects that I am working on	5	4	3	2	1
30. Opportunities to participate in decisions that affect the quality of my work environment	5	4	3	2	1
31. Opportunities to be creative in the work that I do	5	4	3	2	1
32. Desire for more plants and other natural elements in my work area	5	4	3	2	1
33. Feeling cramped or crowded in my work area	5	4	3	2	1
34. Bothered by glare on computer or micro-fiche screen	5	4	3	2	1
35. Feeling too enclosed in my workstation	5	4	3	2	1

QUESTIONNAIRE 2
LOCATION OF WORK ACTIVITIES

1. Please estimate the approximate amount of time you spend in each of the following locations during a typical work day or work week.

Please Note:

- For each item, please estimate either by the day or by the week, but not both. Use whichever method is convenient and appropriate for each item.
- To indicate a portion of an hour, use decimals or fractions, whichever you prefer.
- If you spend no time in a given location, please indicate zero (0) time for this category.

location:	approximate amount of time per day OR week			
a. your own desk	_____ hours/day	**OR**	_____ hours/week	
b. consulting at co-workers' desks:	_____ hours/day	**OR**	_____ hours/week	
c. consulting at supervisor's desk:	_____ hours/day	**OR**	_____ hours/week	
d. elsewhere in your Branch's work area:	_____ hours/day	**OR**	_____ hours/week	
e. in all other offices in your building:	_____ hours/day	**OR**	_____ hours/week	
f. outside of your building:	_____ hours/day	**OR**	_____ hours/week	

2. Please estimate the number of <u>separate trips</u> you make to other departments and offices in the Hamilton District Office in a typical <u>work week</u>. Then please estimate the <u>total amount of time</u> you spend in each of these departments or offices during a typical <u>work week</u>.

Please Note:

- For each item, please estimate by the week, <u>ONLY</u>.
- To indicate a portion of an hour, use decimals or fractions, whichever you prefer.
- If you spend no time in a given location, please indicate zero (0) trips and zero time for this category.
- As one of these offices will be your own office, please write "own office," where you are asked to record the "number of trips". Then please estimate the <u>total amount of time</u> you spend in your own office during a typical work week.

department or office:	total number of trips/week	total number of hours/week
a. **Appeals:**	_____ trips/week	_____ hours/week
b. **Audit:**		
1. Audit Review:	_____ trips/week	_____ hours/week
2. Basic Files:	_____ trips/week	_____ hours/week
3. Business Files:	_____ trips/week	_____ hours/week
4. Electronic Data Processing:	_____ trips/week	_____ hours/week
5. Special Investigations:	_____ trips/week	_____ hours/week
6. Tax Avoidance:	_____ trips/week	_____ hours/week
7. Real Estate Appraisals:	_____ trips/week	_____ hours/week
8. Other Audit:	_____ trips/week	_____ hours/week
c. **Verification and Collections:**		
1. Enquiries and Office Examination:	_____ trips/week	_____ hours/week
2. Collections:	_____ trips/week	_____ hours/week
3. Source Deductions:	_____ trips/week	_____ hours/week
4. Other Verification and Collections:	_____ trips/week	_____ hours/week
d. **Administration and Support:**		
1. Internal Audit:	_____ trips/week	_____ hours/week
2. Forms Distribution:	_____ trips/week	_____ hours/week
3. Training Room:	_____ trips/week	_____ hours/week
4. Other Administration and Support:	_____ trips/week	_____ hours/week
e. **Personnel:**	_____ trips/week	_____ hours/week

3. Please estimate the approximate amount of time you spend using the following equipment during a typical work day or work week.

Please Note:

- For each item, please estimate either by the day or by the week, but not both. Use whichever method is convenient and appropriate for each item.
- To indicate a portion of an hour, use decimals or fractions, whichever you prefer.
- If you do not ever use a particular piece of equipment, please indicate zero (0) time for this category.

office equipment:	**approximate amount of time per day OR week**			
a. personal computer:	_____ hours/day	**OR**	_____ hours/week	
b. other video display units, terminals, or Cathode Ray Tubes:	_____ hours/day	**OR**	_____ hours/week	
c. microfiche or microfilm reader:	_____ hours/day	**OR**	_____ hours/week	
d. photocopier:	_____ hours/day	**OR**	_____ hours/week	
e. typewriter:	_____ hours/day	**OR**	_____ hours/week	
f. telephone:	_____ hours/day	**OR**	_____ hours/week	
g. other office equipment:				
(1) _____	_____ hours/day	**OR**	_____ hours/week	
(2) _____	_____ hours/day	**OR**	_____ hours/week	
(3) _____	_____ hours/day	**OR**	_____ hours/week	

Public Works Canada | Travaux publics Canada

Date	
ID Number	

BUILDING-IN-USE QUESTIONNAIRE

INSTRUCTIONS:

- **Please rate the following attributes of your particular desk location** in this building by circling the appropriate number **between 1 and 5** that best summarizes your experience of working here.

Temperature comfort	1 BAD	2	3	4	5 GOOD
How cold it gets	1 TOO COLD	2	3	4	5 COMFORTABLE
Temperature shifts	1 TOO FREQUENT	2	3	4	5 CONSTANT
Ventilation comfort	1 BAD	2	3	4	5 GOOD
Air freshness	1 STALE AIR	2	3	4	5 FRESH AIR
Air movement	1 STUFFY	2	3	4	5 CIRCULATING
Noise distractions	1 BAD	2	3	4	5 GOOD
Background office noise level	1 TOO NOISY	2	3	4	5 COMFORTABLE
Specific office noises (voices and equipment)	1 DISTURBING	2	3	4	5 NOT A PROBLEM
Furniture arrangement in your workspace	1 BAD	2	3	4	5 GOOD
Amount of space in your workspace	1 BAD	2	3	4	5 GOOD
Work storage	1 INSUFFICIENT	2	3	4	5 ADEQUATE
Personal storage	1 INSUFFICIENT	2	3	4	5 ADEQUATE
Visual privacy at your desk	1 BAD	2	3	4	5 GOOD
Voice privacy at your desk	1 BAD	2	3	4	5 GOOD
Telephone privacy at your desk	1 BAD	2	3	4	5 GOOD

Electrical lighting	1 BAD	2	3	4	5 GOOD
How bright lights are	1 TOO MUCH LIGHT	2	3	4	5 DOES NOT GET TOO BRIGHT
Glare from lights	1 HIGH GLARE	2	3	4	5 NO GLARE
Noise from air systems	1 DISTURBING	2	3	4	5 NOT A PROBLEM
Noise from office lighting	1 BUZZ / NOISY	2	3	4	5 NOT A PROBLEM
Noise from outside the building	1 DISTURBING	2	3	4	5 NOT A PROBLEM
How would you rate your overall satisfaction with your workspace	1 DISSATISFIED	2	3	4	5 VERY SATISFIED
Please rate how this space affects your ability to do your work	1 MAKES IT DIFFICULT	2	3	4	5 MAKES IT EASY

Comments

Thank you for your cooperation. For enquiries about the results of this survey, please contact:

Name	Telephone no.
Audrey Kaplan, Public Works Canada, Ottawa	(613) 998-4317